ON THE MECHANISM OF PERCHING IN BIRDS.[1]

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THE peculiar mode of action of the muscles of the bird's leg, so far as relates to their condition during the act of perching, has long been a subject of interest to Anatomists and Physiologists.

It is well known that even during stormy weather, or when asleep, birds easily maintain their position on the branches of trees. The *rationale* of this had been a puzzle till towards the end of the eighteenth century, when Borelli, in his work *De motu animalium*, stated his opinion that the solution of the difficulty was to be found in the peculiar arrangement of that muscle which Meckel has since described under the name of the Rectus femoris. This muscle arises from the pelvis, immediately in front of the acetabulum, passes obliquely across the convexity of the knee joint and finally, uniting with the flexor perforatus digitorum, is continued through the medium of that muscle to the toes.

This idea seems to have prevailed since that time, for Dr Macartney, the writer of the article "Birds," in *Rees' Cyclopædia*, agrees with Borelli as to the function of that muscle; and Professor Owen, in the *Cyclopædia of Anatomy*, writes as follows:—"The disposition of the former muscle (*i.e.*, Rectus femoris) is such (passing, viz., first over the convexity of the knee joint, and afterwards over the projection of the heel) that from its connection with the flexor of the toes, these must necessarily be bent simultaneously with every inflection of the knee and ankle. As these inflections naturally take place when the lower extremities yield to the superincumbent weight of the body, birds are thus enabled to grasp the twigs on which they rest while sleeping without making any muscular exertion." A passage to the same effect occurs in the same author's recent work on the *Anatomy of the Vertebrates*. Meckel, in his *Anatomie Comparée*, appears also to sanction the above explanation, for, after describing the muscle, he goes on to say

[1] This paper formed a part of a graduation Thesis, "On the Myology of the Hind Limb in Birds," submitted to the Medical Faculty of the University of Edinburgh, March, 1867, for which a gold medal was awarded to the author.

that he has been unable to find it in the Crested Grebe, the Guillemot, and the Cormorant; and adds, "This remark is so much the more curious, that its action on the flexion of the toes is not necessary in these birds."

Since I began to examine into this matter, it has seemed to me that too much stress has been laid upon the peculiar action of this muscle in accounting for the maintenance of the bird securely on its perch without muscular exertion. For the small size of the muscle itself and the mode of its transmission through the medium of the flexor digitorum to the toes, appeared inadequate to account for the effects produced. Dissatisfied, therefore, with the theory, and determined to submit the matter to the test of experiment, I cut down along the inner side of the thigh of a domestic fowl, and securing the tendon of the Rectus, divided it. Two days afterwards I operated in like manner on the muscle of the opposite side. After each operation there was noticed only slight inversion of the foot—the bird walked, ran, and perched as well as before the operations. It was then suggested to me that the experiment was not satisfactory, inasmuch as the cut ends of the tendon might have again united, and thus in reality have left the bird in the same condition as it was previous to the section. Accordingly I operated on a second fowl in like manner, taking, however, the additional precaution to pull upward the tendon of the Rectus, so as to be able to cut away about half an inch of it on each side. As in the first experiment, a slight inversion of the toes was observed, but otherwise the bird conducted itself much as it did before the operation, perching as usual along with its companions.

A third individual was subjected to a similar ordeal, and was examined by Professor Turner, who was satisfied that its powers of perching were in no way interfered with. The bird being killed, the ends of the tendons were found separated by about half an inch, neither having in any way united nor contracted adhesions to neighbouring parts. In all the above experiments, the birds were allowed to have access only to a slender perch, and care was taken to exclude all fallacies as regards their powers of perching.

These experiments, taken in connection with the facts I

shall now communicate as to the absence of this muscle in certain birds, seems perfectly to prove the incorrectness of the theory under review. In the course of an examination of the muscles of the hind limb in a number of birds, I ascertained that the muscle was absent in four birds of this country which habitually perch—viz., the blackbird, magpie, thrush, and starling, —while it was present in several which never under any circumstances perch, such as the swan, black scoter and black headed gull.

The only other theory as to the function of this muscle with which I am acquainted is that advanced by the Rev. Samuel Haughton, of Dublin, in the *Proceed. Roy. Irish Academy*, 1865, Vol. IX., who considers it only with reference to the ostrich. He states that it is an arrangement whereby dislocation of the leg is prevented in this bird during the sudden and violent extension of the joints which occurs when the creature is in rapid motion. This theory, however ingenious, is, I am afraid, hardly tenable, for the reason that the Rectus is quite as well developed in proportion to the size of the bird in the diving sea ducks, such as the black scoter, and in the true swimmers, such as the swan, as it is in the ostrich. In these birds, no such violent extension of the leg takes place as would necessitate such an arrangement in order to prevent dislocation, supposing for the time being that it were effective in this respect, which is doubtful. In the ostrich, moreover, the arrangement and enormous strength of the ligaments is such as would effectually prevent any dislocation even during the most violent movements of the animal.

The true explanation of the act of perching is, I believe, to be found in the peculiar arrangement of certain muscles of the limb in birds—viz., the Biceps, Flexor perforatus digitorum, Flexor longus pollicis, and Tibialis anticus. Of these muscles the three latter have their origins carried up to the femur, which so far as I can ascertain, occurs in no other class of vertebrate animals except that of birds[1], whilst the tendon of the biceps passes through a fibrous pulley attached to the lower end of the femur before it is inserted into the head of the fibula. It will be observed that each of these muscles passes

[1] Professor Humphry has since informed me that he finds in Pteropus the flexor of the toes continued up to the femur (see p. 314).

over at least two joints, and they are so arranged that when the limb is fully flexed as it is in the act of perching, they shall, each and all of them, be passively stretched. In no other position of the limb does this occur.

Bearing these facts in mind, let us observe what takes place when a bird settles upon a branch. In the first place, the muscles which act directly as flexors of the hip-joint, more especially the Gluteus medius and minimus (Meckel), come into play. Or it may be that the bird, abstaining from all muscular exertion, the weight of the body is sufficient to accomplish the flexion of this joint. This flexion of the hip-joint, however, necessitates a corresponding flexion of the knee, as the hamstrings, and more especially the Biceps from the peculiar arrangement of its tendon of insertion, are not sufficiently long to admit of flexion of the one joint without that of the other. And here I would point out that, were it not for the fibrous pulley through which the tendon of insertion of the Biceps passes, the different functions of that muscle could not be efficiently performed. For were the muscle attached directly to the fibula, without passing in the first place through this fibrous loop, either it would be too short to admit of the requisite extension of the knee-joint, or were it sufficiently long to allow of this, it would not fulfil the conditions necessary to secure the bird firmly in its position without loss of muscular exertion. In other words, it could not then be passively stretched. Furnished with this pulley, however, the Biceps is enabled to fulfil both conditions, as it is evident that, by so much as the knee and hip-joints are flexed, by so much is the pulley drawn forwards, and the Biceps correspondingly put upon the stretch; whilst, when the limb is extended, the muscle acts much as if no pulley were present and, therefore, retains the requisite length.

The knee-joint being flexed, it will be observed that the point of insertion of the Sartorius into the front of the tibia will be removed farther from its point of origin at the pelvis than during extension of the joint, and as its tendon of insertion is at the same time compelled to pass in front of the convexity of the knee, it is evident that the entire muscle must be passively extended. We have therefore the body of the bird secured both in front of and behind the hip-joint—in the former

direction by the Sartorius, in the latter by the Biceps. Simultaneously, moreover with the flexion of the knee, the point of origin of the Tibialis anticus from the front of the external condyle of the femur, being rotated upwards, is removed to a greater distance from its insertion into the front of the tarso-metatarsal bone, and it will follow that, in order to avoid rupture of the muscle, the latter point must be approximated to the former, and this can only be accomplished by flexion of the ankle-joint. In the act of flexing this joint, the heel being thrown backwards, the long flexors of the toes are necessarily drawn tense; and as the tendons passing to the toes in front are closely connected with that one passing to the posterior toe, they are consequently put upon the stretch at the same moment, and thus compel the toes to grasp firmly the branch on which the bird is situated.

Here it may be asked, Why should the origin of the flexor muscles of the toes be transferred to the femur? Simply, I believe, to procure consentaneous flexion of all the joints from the knee to the toes, as it is evident that when this muscle flexes the toes, it must also flex the knee in this portion of the bird. Doubtless it may be said that the Gastrocnemius is sufficient to effect this latter movement, when the Flexor digitorum has its usual origin from the tibia, yet it is evident that there cannot be the same security in this respect when *several* muscles pass over the separate joints as when *one* muscle, as the Flexor digitorum, passes over all of them. It will thus be seen that by means of the mechanism just described, the bird is enabled to perch securely, and that the arrangement of the muscles is such, that by simple flexion of the limb, those passing in front of as well as those passing behind the various joints are necessarily drawn tense, and thus as it were brace the bird to its perch without any exertion of muscular action on its part. That the Rectus femoris may assist those birds in which it is present to perch, I do not deny; but that it is the principal, or even an essential agent in effecting this, is, I think, sufficiently disproved by the facts mentioned in the first part of this paper.

The ease with which the Grallatorial birds, as well as some belonging to other orders, poise themselves when asleep upon one leg, has also been referred by some to the action of the Rectus femoris. In this case, as in the former, the statement

appears to me to rest upon insufficient data. I have ascertained, in the course of my dissections, that not only in the Flamingo and Curlew is this muscle more slightly developed than in the generality of birds; but that in the Heron, which also habitually assumes this position, the muscle is entirely absent. The true explanation of this action is, as it seems to me, to be referred to the arrangement of the Tibialis anticus before mentioned. It will be observed that when the hip and knee joints are flexed to the utmost, as they always are in such cases, that the Biceps and Sartorius will co-operate in balancing the bird precisely as in the act of perching. The Tibialis anticus being drawn tense when the knee is flexed, the foot at the same time being fixed, this muscle will, by virtue of the annular ligament which confines its tendon at the lower end of the tibia, produce extension of the ankle-joint. The body will accordingly be balanced in this position, without loss of muscular exertion, if the leg be brought sufficiently under the centre of the body to counteract *lateral* displacement. This explanation receives confirmation from the fact that on dividing the femoral head of origin of the Tibialis anticus on both sides, the bird, when placed on the perch, had the utmost difficulty in balancing itself, except when *all* the joints were completely flexed.

With reference to this question it is of interest to remark that in those Grallatorial birds which I have had an opportunity of examining, the Biceps, in addition to its usual origin, is connected to the posterior border of the Gluteus maximus (Meckel), which arises from the pelvis *above* the acetabulum. Hence at the same time that the Biceps is passively extended, it will tend to bring the median plane, and consequently the centre of gravity of such birds more directly over the single limb on which it is poised.

That the muscles, to the consideration of which this paper has been devoted, have other and more important functions to perform is evident from the fact that they are present in many birds which never assume either of the positions I have referred to. I submit, however, that the special arrangements I have noted afford a rational explanation of the facts when they do occur, and at the same time it is to be observed that the *majority* of birds do habitually occupy one or other of the positions I have been considering.